by Tara McHugh

# How Dark Chocolate Is Processed

This month's column will continue the theme of "How Is It Processed?" The column will focus on dark chocolate. The botanical name for the cacao tree is *Theobroma cacao,* which literally means "food of the Gods." Dark chocolate is both delicious and nutritious. Production of dark chocolate will be described, as will effects of processing on the final product properties of this healthy food.

## History, Market, and Nutrition

Dark chocolate history goes back at least 3,000 years. Early on, dark chocolate was the only form of chocolate available. It was developed around 1900 B.C. as a beverage in what is now Central and South America. Later the Mayans and the Aztecs made bitter dark chocolate beverages for ceremonial and medicinal purposes. The Spanish brought chocolate back to Europe and added cane sugar or honey to the formula to sweeten it. It wasn't until 1689 that milk was added to traditional dark chocolate drinks by Hans Sloan in Jamaica, making the first milk chocolate. During the 20th century, mass distribution greatly increased the popularity of milk chocolate, and in the late 20th century, dark chocolate regained popularity due to its health benefits.

Worldwide consumption of chocolate is estimated to be at least 7.2 million metric tons annually. The United States accounts for 20% of the world consumption of chocolate with a monetary value of approximately $20 billion. Europe consumes close to 50% of the world's chocolate. The average European consumes 24 pounds of chocolate a year, and the average American consumes half that amount. Dark chocolate represents approximately 20% of overall chocolate consumed in the United States and 30% of all chocolate consumption in Switzerland.

***Conching can smooth out harshly acidic flavor notes,*** *developing uniform flavor and smooth texture in the chocolate.*

***Beans from the cacao tree****—shown here in the pod—are the key raw ingredient in making chocolate.*
Photo courtesy of USDA Agricultural Research Service

The 2010 *Report of the Dietary Guidelines Advisory Committee* supports incorporating moderate amounts of dark chocolate as part of a healthy, balanced diet. Nutritionally, dark chocolate and its main ingredient, cocoa, have been shown to reduce risk factors for heart disease. Flavonoids, which are more prevalent in dark chocolate than in milk chocolate, have been shown to help lower blood pressure and improve vascular function. Flavonoids in cocoa beans also have antioxidant effects that reduce cell damage implicated in heart disease. In addition, some research has linked chocolate consumption to reduced risks of diabetes, stroke, and heart attack. Research is ongoing in these and other areas, such as the potential of chocolate to improve cognitive function.

## Dark Chocolate Processing

• **Bean Growth and Harvesting.** Cocoa beans grow best under the canopy of tropical rain forests typically located within 20 degrees of the equator. There

are three main types of cocoa plants, Forastero, Criollo, and Trinitario, which is a hybrid of the first two types. Forastero is now the most common commercial type and produces beans with the strongest flavor. Beans are allowed to ripen on the trees. As they ripen, the pods develop a rich golden-orange or red color depending on the type. The pods are harvested primarily by hand. They are split open, and the beans, which are covered with pulp, are removed from the fruit.

• **Fermentation and Drying.** The fermentation of cocoa beans is the critical step in developing the full flavor potential of the cocoa bean. It is a spontaneous process conducted directly after harvesting the cocoa fruit (pods). Although fermentation is commonly performed using naturally present yeasts, some chocolate manufacturers add yeast-based starter cultures that have been optimally adapted to the cocoa fermentation. The pulp liquefies during fermentation. Fermentation is commonly performed in heaps covered by leaves or in wooden sweating boxes. The process lasts five to seven days, and the temperature and humidity at which it takes place, as well as the frequency with which the beans are turned for aeration, determine the flavor profile a roasted and ground bean will ultimately possess. The goal of fermentation is to develop complex flavors.

The fermented beans are then dried in the sun on mats or using specialized driers to stabilize them and prevent mold growth. Beans are normally dried to approximately 6%–7% percent moisture prior to bagging.

• **Roasting.** Cocoa beans are roasted in ovens at temperatures between 105°C and 150°C. Typical process times range from 20 min to 30 min. During roasting, the cocoa beans darken to a rich, dark brown color and they develop additional flavor and aroma notes. Roasting also puffs up the shells making them easier to remove during the next processing step and further dries the beans to moisture contents close to 2%.

• **Winnowing, Grinding/Milling, and Refining.** After roasting, the beans run through a winnowing machine that cracks the lighter hulls (shells) and blows them away with a fan, leaving the pieces of inner bean called "nibs," which contain approximately 53% cocoa butter. The nibs are then ground. The design of the grinder may vary, but many resemble old-fashioned flour mills. The grinding/milling process produces friction from heat and results in chocolate liquor, small particles of nibs suspended in oil. Some of the liquor may be pressed at this point, removing cocoa butter and resulting in a dry press cake that can be ground into cocoa powder. Alternately, the liquor may be mixed with other ingredients such as cocoa butter, sugar, vanilla, and emulsifying agents such as soy lecithin, after which the liquor is ground further between sets of revolving metal drums to reduce the size of particles in the liquor to about 0.00254 cm and distribute the cocoa butter evenly through the matrix. Roll refiners and ball mills are typically used for this purpose. If milk is added, the resulting chocolate is milk chocolate, and if no chocolate liquor is used but only cocoa butter, the resulting chocolate is white chocolate.

• **Alkalization or Dutching.** Alkalization or "dutching" is a processing technique that is sometimes used in making cocoa powder and chocolate. Alkalization includes treating cocoa nibs and/or chocolate liquor with a mild alkali solution in order to raise the pH. It can improve the taste by reducing bitterness, increasing the solubility of cocoa powder, and creating a dark brown/red-brown color. In addition, during the alkalization process, the flavanol content may be reduced and, as a result, the potential health benefits that may be delivered may also be reduced.

***Rollers produce a smooth emulsion*** *during the conching phase of chocolate processing.* © IMNATURE/iStock/Thinkstock

• **Conching.** A conch is a surface scraping mixer and agitator that evenly distributes cocoa butter within chocolate. It also promotes flavor development through frictional heat, release of volatiles and acids, and oxidation. Conching can smooth out harshly acidic flavor notes, developing uniform flavor and smooth texture in the chocolate. There are numerous designs of conches, including granite rollers and troughs in both batch and continuous systems. Slow stirring in a vat called a conche containing rollers or paddles is one

## How Dark Chocolate Is Processed continued...

option that allows liquid chocolate to be mixed, aerated, kneaded, and agitated. The conching process can take from four hours to three days. Conching and refining may occur in one combined step or two separate steps as described here.

• **Tempering.** The second-to-last step in the manufacturing of dark chocolate is tempering. Tempering is important to control the crystallization of the cocoa butter and allows the crystals to pack tightly together. Uncontrolled crystallization results in crystals of varying sizes and causes the surface of chocolate to appear mottled, resulting in an unsightly white coating called fat bloom. It also results in a poor final texture that crumbles rather than snapping when broken.

The fats in cocoa butter can crystallize into six different forms, each of which has a different melting temperature. Good chocolate contains type V crystals, resulting in chocolate with a uniform glossy appearance and a good texture that snaps when broken. During tempering, chocolate is first heated to 45°C to melt all six forms of crystals. Next it is cooled to about 27°C to allow crystal types IV and V to form. It is then agitated to create small crystal "seeds," which serve as nuclei to create additional small crystals in the chocolate. The chocolate is then heated to 31°C to eliminate the type IV crystals, leaving only type V crystals. An alternative method to tempering involves adding already tempered, solid "seed" chocolate.

• **Forming Into Final Products.** After tempering, the dark chocolate is ready to be molded into final product forms.

### Recent Innovations

A good deal of recent research has focused on novel fermentation and drying methods for chocolate. An example of this is the development of custom yeast starter cultures for fermentation. In addition, Mars patented the use of airtight bags to avoid off-flavor development during fermentation. The use of special polyethylene sheets is being developed to convert the sun's ultraviolet rays to infrared, heating the beans to 50°C–60°C during sun drying and allowing the beans to reach the final 7% moisture content faster than regular sun drying. Research on optimization of processing conditions to enhance the nutritional properties of dark chocolate is also underway. **FT**

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### REFERENCE

U.S. Patent Application Number 20150374007.